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SECTION -I

1. Consider page references,

0,3,4,1,2,5,7,6,0,3,1,11,5,15,9,4,0,4,

3 Cache size= 8

Mainmemory= 64

Offset/word=0

Calculate the hit ratio and miss ratio for the given references using direct mapping and fully associative FIFO and 2 way set associative FIFO.

ANSWER-

FULLY ASSOCIATIVE

Replacement Policies

☒ FIFO ☐ LRU ☐ Random

Write Policies

☒ Write Back ☐ Write Through

☒ Write On Allocate ☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load

(in hex)#

0,3,4,1,2,5,7,6,0,3,1,11,5,15,9,4,0,4,3

Gen. Random

Submit

Information

Offset = 0 bits

Instruction Length = $\log_2(64) = 6$ bits

Block = 6 bits - 0 bits = 6 bits

Please submit Instruction.

Next

Fast Forward

Statistics

Hit Rate :

Miss Rate :

FULLY ASSOCIATIVE CACHE

Instruction Breakdown

BLOCK	OFFSET
6 bit	0 bit

Memory Block

B.0.W.0
B.1.W.0
B.2.W.0
B.3.W.0
B.4.W.0
B.5.W.0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0
4	0	-	0	0
5	0	-	0	0
6	0	-	0	0
7	0	-	0	0

Replacement Policies

☒ FIFO
 ☐ LRU
 ☐ Random

Write Policies

☒ Write Back
 ☐ Write Through

☒ Write On Allocate
 ☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load

(in hex)#

List of next 10 Instructions

Submit

Information

The cycle has been completed.
Please submit another instructions

Next

Fast Forward

FULLY ASSOCIATIVE CACHE

Instruction Breakdown

000011

0

6 bit

0 bit

Memory Block

B.3 W.0

B.4 W.0

B.5 W.0

B.6 W.0

B.7 W.0

B.8 W.0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	010001	BLOCK 11 WORD 0 - 0	0
1	1	010101	BLOCK 15 WORD 0 - 0	0
2	1	001001	BLOCK 9 WORD 0 - 0	0
3	1	000100	BLOCK 4 WORD 0 - 0	0
4	1	000000	BLOCK 0 WORD 0 - 0	0
5	1	000011	BLOCK 3 WORD 0 - 0	0
6	1	000111	BLOCK 7 WORD 0 - 0	0
7	1	000110	BLOCK 6 WORD 0 - 0	0

Next

Fast Forward

Statistics

Hit Rate : 26%

Miss Rate : 74%

List of Previous Instructions :

- Load 0 [Miss]
- Load 3 [Miss]
- Load 4 [Miss]
- Load 1 [Miss]
- Load 2 [Miss]
- Load 5 [Miss]
- Load 7 [Miss]
- Load 6 [Miss]
- Load 0 [Hit]
- Load 3 [Hit]
- Load 1 [Hit]
- Load 11 [Miss]
- Load 5 [Hit]
- Load 15 [Miss]
- Load 9 [Miss]
- Load 4 [Miss]
- Load 0 [Miss]
- Load 4 [Hit]
- Load 3 [Miss]

Next Index: 6

Last Index: 5

2-WAY SET ASSOCIATIVE

Replacement Policies

☒ FIFO
 ☐ LRU
 ☐ Random

Write Policies

☒ Write Back
 ☐ Write Through

☒ Write On Allocate
 ☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load

(in hex)#

0,3,4,1,2,5,7,6,0,3,1,11,5,15,9,4,0,4,3

Gen. Random

Submit

Information

Offset = 0 bits

Index bits = $\log_2(8/1/2) = 2$ bits

Instruction Length = $\log_2(64) = 6$ bits

Tag = 6 bits - 0 bits - 2 bits = 4 bits

Block = 4 bits + 2 bits = 6 bits

Next

Fast Forward

Statistics

Hit Rate :

Miss Rate :

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
4 bit	2 bit	0 bit

Memory Block

B.0 W.0
 B.1 W.0
 B.2 W.0
 B.3 W.0
 B.4 W.0
 B.5 W.0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0

Replacement Policies

☒ FIFO
 ☐ LRU
 ☐ Random

Write Policies

☒ Write Back
 ☐ Write Through

☒ Write On Allocate
 ☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load

(in hex)#

List of next 10 Instructions

Gen. Random

Submit

Information

The cycle has been completed.

Please submit another Instructions

Next

Fast Forward

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

0000	11	0
4 bit	2 bit	0 bit

Memory Block

B.9 W.0
 B.A W.0
 B.B W.0
 B.C W.0
 B.D W.0
 B.E W.0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	0	B.0 W.0 - 0	0
1	1	2	BLOCK 9 WORD 0 - 0	0
2	1	0	B.2 W.0 - 0	0
3	1	0	B.3 W.0 - 0	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	1	BLOCK 4 WORD 0 - 0	0
1	1	5	BLOCK 15 WORD 0 - 0	0
2	1	1	BLOCK 6 WORD 0 - 0	0
3	1	1	BLOCK 7 WORD 0 - 0	0

Please submit another instructions

Next

Fast Forward

Statistics

Hit Rate : 42%

Miss Rate : 58%

List of Previous Instructions :

- Load 0 [Miss]
- Load 3 [Miss]
- Load 4 [Miss]
- Load 1 [Miss]
- Load 2 [Miss]
- Load 5 [Miss]
- Load 7 [Miss]
- Load 6 [Miss]
- Load 0 [Hit]
- Load 3 [Hit]
- Load 1 [Hit]
- Load 11 [Miss]
- Load 5 [Hit]
- Load 15 [Miss]
- Load 9 [Miss]
- Load 4 [Hit]
- Load 0 [Hit]
- Load 4 [Hit]
- Load 3 [Hit]

DIRECT MAPPING

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load (in hex)#

0,3,4,1,2,5,7,6,0,3,1,11,5,15,9,4,0,4,3

Gen. Random

Submit

Information

Offset = 0 bits

Index bits = $\log_2(8/1) = 3$ bits

Instruction Length = $\log_2(64) = 6$ bits

Tag = 6 bits - 0 bits - 3 bits = 3 bits

Block = 3 bits + 3 bits = 6 bits

Next

Fast Forward

Statistics

Hit Rate :

Miss Rate :

List of Previous Instructions :

DIRECT MAPPED CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
3 bit	3 bit	0 bit

Memory Block

B 0 W 0

B 1 W 0

B 2 W 0

B 3 W 0

B 4 W 0

B 5 W 0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0
4	0	-	0	0
5	0	-	0	0
6	0	-	0	0
7	0	-	0	0

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

8

Memory Size (power of 2)

64

Offset Bits

0

Reset

Submit

Instruction

Load (in hex)#

List of next 10 Instructions

Submit

Information

The cycle has been completed.

Please submit another Instructions

Next

Fast Forward

DIRECT MAPPED CACHE

Instruction Breakdown

000	011	0
3 bit	3 bit	0 bit

Memory Block

B 3 W 0

B 4 W 0

B 5 W 0

B 6 W 0

B 7 W 0

B 8 W 0

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	000	BLOCK 0 WORD 0 - 0	0
1	1	001	BLOCK 9 WORD 0 - 0	0
2	1	000	BLOCK 2 WORD 0 - 0	0
3	1	000	BLOCK 3 WORD 0 - 0	0
4	1	000	BLOCK 4 WORD 0 - 0	0
5	1	010	BLOCK 15 WORD 0 - 0	0
6	1	000	BLOCK 6 WORD 0 - 0	0
7	1	000	BLOCK 7 WORD 0 - 0	0



2. Consider 2 way set associative mapping with following design : cache memory is 16bytes and main memory is 256 bytes. The offset bits is 2 . calculate the hit ratio and miss ratio for the following sequence:

3,6,0,8,5,1c,14,15,2,1D,11

Use LRU and FIFO as replacement policy.

Calculate the hit ratio and miss ratio for the same references using direct mapping.

Suggest which is better mapping technique and justify the same.

ANSWER-

FIFO

Replacement Policies

☒ FIFO ☐ LRU ☐ Random

Write Policies

☒ Write Back ☐ Write Through

☒ Write On Allocate ☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

3,6,0,8,5,1c,14,15,2,1d,11

Gen. Random

Submit

Information

Offset = 2 bits

Index bits = $\log_2(16/4/2) = 1$ bits

Instruction Length = $\log_2(256) = 8$ bits

Tag = 8 bits - 2 bits - 1 bits = 5 bits

Block = 5 bits + 1 bits = 6 bits

Next

Fast Forward

Statistics

Hit Rate :

Miss Rate :

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
5 bit	1 bit	2 bit

Memory Block

B 0 W 0	B 0 W 1	B 0 W 2	B 0 W 3
B 1 W 0	B 1 W 1	B 1 W 2	B 1 W 3
B 2 W 0	B 2 W 1	B 2 W 2	B 2 W 3
B 3 W 0	B 3 W 1	B 3 W 2	B 3 W 3
B 4 W 0	B 4 W 1	B 4 W 2	B 4 W 3
B 5 W 0	B 5 W 1	B 5 W 2	B 5 W 3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0

Replacement Policies

☒ FIFO ☐ LRU ☐ Random

Write Policies

☒ Write Back ☐ Write Through

☒ Write On Allocate ☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

List of next 10 Instructions:

Load 3 [Miss]

Submit

Information

The cycle has been completed.

Please submit another instructions

Next

Fast Forward

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
00010	0	01
5 bit	1 bit	2 bit

Memory Block

B 4 W 0	B 4 W 1	B 4 W 2	B 4 W 3
B 5 W 0	B 5 W 1	B 5 W 2	B 5 W 3
B 6 W 0	B 6 W 1	B 6 W 2	B 6 W 3
B 7 W 0	B 7 W 1	B 7 W 2	B 7 W 3
B 8 W 0	B 8 W 1	B 8 W 2	B 8 W 3
B 9 W 0	B 9 W 1	B 9 W 2	B 9 W 3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	2	BLOCK 4 WORD 0 - 3	0
1	1	2	BLOCK 5 WORD 0 - 3	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	1	BLOCK 2 WORD 0 - 3	0
1	1	3	BLOCK 7 WORD 0 - 3	0

Statistics

Hit Rate : 45%

Miss Rate : 55%

List of Previous Instructions :

- Load 3 [Miss]
- Load 6 [Miss]
- Load 0 [Hit]
- Load 8 [Miss]
- Load 5 [Hit]
- Load 1C [Miss]
- Load 14 [Miss]
- Load 15 [Hit]
- Load 2 [Hit]
- Load 1D [Hit]
- Load 11 [Miss]

LRU

Replacement Policies

☐ FIFO

☒ LRU

☐ Random

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

(n hex)#

3,6,0,8,5,1c,14,15,2,1d,11

Gen. Random

Submit

Information

Offset = 2 bits

Index bits = $\log_2(16/4/2) = 1$ bits

Instruction Length = $\log_2(256) = 8$ bits

Tag = 8 bits - 2 bits - 1 bits = 5 bits

Block = 5 bits + 1 bits = 6 bits

Next

Fast Forward

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
5 bit	1 bit	2 bit

Memory Block

B 0 W 0	B 0 W 1	B 0 W 2	B 0 W 3
B 1 W 0	B 1 W 1	B 1 W 2	B 1 W 3
B 2 W 0	B 2 W 1	B 2 W 2	B 2 W 3
B 3 W 0	B 3 W 1	B 3 W 2	B 3 W 3
B 4 W 0	B 4 W 1	B 4 W 2	B 4 W 3
B 5 W 0	B 5 W 1	B 5 W 2	B 5 W 3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0

Replacement Policies

☐ FIFO

☒ LRU

☐ Random

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

(n hex)#

List of next 10 Instructions

Submit

Information

Offset = 2 bits

Index bits = $\log_2(16/4/2) = 1$ bits

Instruction Length = $\log_2(256) = 8$ bits

Tag = 8 bits - 2 bits - 1 bits = 5 bits

Block = 5 bits + 1 bits = 6 bits

Next

Fast Forward

2-WAY SET ASSOCIATIVE CACHE

Instruction Breakdown

00010	0	01
5 bit	1 bit	2 bit

Memory Block

B 4 W 0	B 4 W 1	B 4 W 2	B 4 W 3
B 5 W 0	B 5 W 1	B 5 W 2	B 5 W 3
B 6 W 0	B 6 W 1	B 6 W 2	B 6 W 3
B 7 W 0	B 7 W 1	B 7 W 2	B 7 W 3
B 8 W 0	B 8 W 1	B 8 W 2	B 8 W 3
B 9 W 0	B 9 W 1	B 9 W 2	B 9 W 3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	0	B. 0 W. 0 - 3	0
1	1	2	BLOCK 5 WORD 0 - 3	0

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	2	BLOCK 4 WORD 0 - 3	0
1	1	3	BLOCK 7 WORD 0 - 3	0

Statistics

Hit Rate : 45%

Miss Rate : 55%

List of Previous Instructions :

- Load 3 [Miss]
- Load 6 [Miss]
- Load 0 [Hit]
- Load 8 [Miss]
- Load 5 [Hit]
- Load 1C [Miss]
- Load 14 [Miss]
- Load 15 [Hit]
- Load 2 [Hit]
- Load 1D [Hit]
- Load 11 [Miss]

DIRECT MAPPING

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

(in hex#)

3,6,0,8,5,1c,14,15,2,1d,1f

Gen. Random

Submit

Information

Offset = 2 bits

Index bits = $\log_2(16/4) = 2$ bits

Instruction Length = $\log_2(256) = 8$ bits

Tag = 8 bits - 2 bits - 2 bits = 4 bits

Block = 4 bits + 2 bits = 6 bits

Next

Fast Forward

DIRECT MAPPED CACHE

Instruction Breakdown

TAG	INDEX	OFFSET
4 bit	2 bit	2 bit

Memory Block

B.0W.0	B.0W.1	B.0W.2	B.0W.3
B.1W.0	B.1W.1	B.1W.2	B.1W.3
B.2W.0	B.2W.1	B.2W.2	B.2W.3
B.3W.0	B.3W.1	B.3W.2	B.3W.3
B.4W.0	B.4W.1	B.4W.2	B.4W.3
B.5W.0	B.5W.1	B.5W.2	B.5W.3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	0	-	0	0
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0

Write Policies

☒ Write Back

☐ Write Through

☒ Write On Allocate

☐ Write Around

Cache Size (power of 2)

16

Memory Size (power of 2)

256

Offset Bits

2

Reset

Submit

Instruction

Load

(in hex#)

List of next 10 Instructions

Gen. Random

Submit

Information

The cycle has been completed.

Please submit another instructions

DIRECT MAPPED CACHE

Instruction Breakdown

0001	00	01
4 bit	2 bit	2 bit

Memory Block

B.4W.0	B.4W.1	B.4W.2	B.4W.3
B.5W.0	B.5W.1	B.5W.2	B.5W.3
B.6W.0	B.6W.1	B.6W.2	B.6W.3
B.7W.0	B.7W.1	B.7W.2	B.7W.3
B.8W.0	B.8W.1	B.8W.2	B.8W.3
B.9W.0	B.9W.1	B.9W.2	B.9W.3

Cache Table

Index	Valid	Tag	Data (Hex)	Dirty Bit
0	1	0001	BLOCK 4 WORD 0 - 3	0
1	1	0001	BLOCK 5 WORD 0 - 3	0
2	1	0000	BLOCK 2 WORD 0 - 3	0
3	1	0001	BLOCK 7 WORD 0 - 3	0

Statistics

Hit Rate : 45%

Miss Rate : 55%

List of Previous Instructions :

• Load 3 [Miss]

• Load 6 [Miss]

• Load 0 [Hit]

• Load 8 [Miss]

• Load 5 [Hit]

• Load 1C [Miss]

• Load 14 [Miss]

• Load 15 [Hit]

• Load 2 [Hit]

• Load 1D [Hit]

• Load 11 [Miss]

BOTH TYPE OF MAPPING ARE EQUALLY EFFICIENT AS THEY BOTH HAVE SAME HIT RATIO.